Topics to study for making ESS less expensive:

1.) Go to the highest real estate gradient. This may require additional focusing in the cryo-modules to avoid partitioning problems.
2.) Go to higher energies to lower the current and losses.
3.) What are the economic ring limits at higher energies
4.) Use of Permanent Magnets reduces costs in terms of gallery space, utility loads and tunnel penetrations.
5.) Make the shortest possible HEBT
6.) Use of klystrons with high power -> more cavities per klystron, fewer low level feedback networks, interlock and water circuits and power supplies. Have least number of waveguide splitters possible. Can you use a series of directional couplers instead of hybrid splitters? This requires low or well-matched Lorentz detuning. Low microphonics, and a feedback system that can do energy and transverse phase space correction
7.) Is the H^- current is "limited", because the warm DTL requires the small emittance of less than 0.3 π mm mrad.
8.) If we can get 200 mA H- out of a source in an emittance of 2 pi, we have to think about a DTL with a much larger acceptance.
9.) The Superconducting H-type System as it is planned to be prototyped at Frankfurt University has certainly large enough acceptance. Los Alamos is building a superconducting 3 gap spoke type cavity, Juelich is studying a 10 gap Spoke type cavity. The spoke type cavities would have large enough acceptance like 5 pi.
10.) What are the limits for the H^- current out of the source. Is it possible to get 150 mA of current in a relatively large emittance.
11.) Lets discus a
150 mA H^- source followed by
a large acceptance RFQ followed by a (~5 MeV)
superconducting H-type -structure (~100-200MeV), followed by
superconducting elliptic cavities with 40Mv/m (~1000-3000 MeV)
12.) Lets discus a 800 MeV FFAG system. At KeK is presently a 150 MeV Prototype under construction.
13.) Lets discus a synchrotron for a high energy regime (>2GeV).